

Minimization of Beam Emittance

Wen Wei Ho
Mentor: Chun-xi Wang

Rationale and Physics

Low emittance is desired since:

- Greater brilliance of light from synchrotron radiation
- Preserves beam quality in arcs of energy-recovery linac-based light sources
- Greater luminosity

Physics behind emittance:

- Radiation damping
- Quantum excitation

$$\epsilon_x = C_q \gamma^2 \frac{\langle \mathcal{H} / |\rho|^3 \rangle}{J_x \langle 1/\rho^2 \rangle}$$

$$\mathcal{H} = \gamma \eta^2 + 2\alpha \eta \eta' + \beta \eta'^2$$

Work done so far

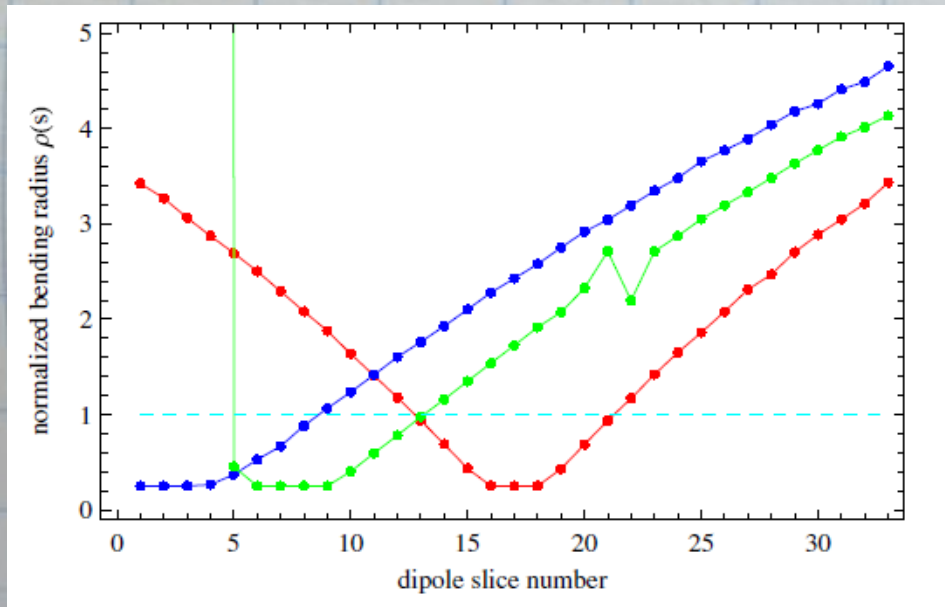
- Equations reduce to:

$$2\sqrt{|A|} \begin{cases} 1 & \text{AME} \\ \sqrt{1-c} & \text{TME} \\ \sqrt{\frac{[1+(q+3)qc/2]\{1+[(1+\tau)q+3]qc/2\}}{1+qc}}, & \text{EME,} \end{cases}$$

$$A = \langle\langle \hat{\xi} \hat{\xi}^T \rangle\rangle \quad \text{and} \quad B = \langle\langle \hat{\xi} \rangle\rangle \langle\langle \hat{\xi} \rangle\rangle^T / \check{\rho}.$$

$$c = -\frac{\text{Tr}(JAJB)}{|A|}.$$

- Optimization of the bending profile, $\rho(s)$



Work done, work in progress, and work to be done

- Have obtained analytical expressions for minimal emittance for optimal profile (symmetric linear-flat-linear profile)
- Have obtained analytical expressions for the case of an undulator
- In the process of refining theory
- To consider the case of asymmetric profiles
- To attempt a variational method as another approach to the optimization problem